Chapter 8. Tulare Lake Hydrologic Region

Setting

The Tulare Lake Hydrologic Region or Basin is in the southern end of the Central Valley. It includes Fresno, Tulare, Kings and Kern counties. Major cities are Fresno, Bakersfield and Visalia. The Tulare Lake region is one of the nation's leading areas in agricultural production with a wide variety of crops on about 3 million acres. Agricultural production has been a mainstay of the region since the late-1800s. Gross farm receipts from the region account for 35 percent of the state's total agricultural economy. This region's population is growing. Its population began increasing above historical trends in the 1980s. As property in the large metropolitan coastal areas became less affordable, many people moved to a more affordable Central Valley. This trend has accelerated in recent years, and the California Department of Finance reported the population at 2 million in 2001.

Native habitat in the region includes vernal pools, areas of valley sink scrub and saltbush, freshwater marsh, grasslands, arid plains, and oak savannah. Agriculture in the Central Valley has replaced much of the historic native grassland, woodland, and wetland.

A map and table of statistics describing the region are presented in Figure 8-1.. The largest river is the San Joaquin, which flows along the northern border of the region. The California Aqueduct extends the entire length of the west side of the region, delivering water to State Water Project and Central Valley Project contractors in the region and exporting water over the Tehachapi Mountains to Southern California. Significant rivers in the region include the Kings, Kaweah, Tule and Kern rivers, which drain into the valley floor of this hydrologically closed region. The Kern River historically terminated in two small lakes, Kern Lake and Buena Vista Lake. These lakes have been dry for many decades; the waters that once fed them have long since been diverted to irrigation. No significant rivers or creeks drain eastward from the Coast Ranges into the valley.

Climate

Land in the region is well suited for farming. The valley portion of the region is hot and dry in summer with long, sunny days and cooler nights. Winters are wet and often blanketed with dense fog. Nearly all of the year's rain falls in the six months from November to April. The southern San Joaquin Valley comprises the Tulare Lake region. The valley is broad and flat surrounded by the Diablo and Coast Ranges to the west, the Sierra Nevada foothills to the east, and the Tehachapi Mountains to the south. The surrounding mountains result in the comparative isolation of the region from marine effects. Because of this and the comparatively cloudless summers, normal maximum temperature advances to a high of 101 degrees in late July. Valley winter temperatures are usually mild, but during infrequent cold spells readings occasionally drop below freezing. Heavy frost occurs during the winter almost every year. The valley is oriented from the northwest to southeast, and northwest winds are common.

The mean annual precipitation in the valley portion of the region ranges from about 6 to 11 inches, with 67 percent falling from December through March, and 95 percent falling during October through April. The Tulare Lake region enjoys a very high percentage of sunshine, receiving more than 70 percent of the maximum during all but November, December, January, and February. During periods of tule fog, which can last up to two weeks, sunshine is reduced to a minimum. This fog frequently extends to a few hundred feet above the surface of the valley and presents the appearance of a heavy, solid cloud layer. These prolonged periods of fog and low temperatures are important to the deciduous fruit industry.

Population

The rate of population growth in the San Joaquin Valley is among the highest in the state, creating a greater demand for housing and urban infrastructure. The population in the Tulare Lake Region is about 52 percent of the entire San Joaquin Valley population. While many communities in the region welcome the growth and income from a diversifying economy, they are beginning to feel the effects of growth on farmland. In six years, between 1992 and 1998, nearly 37,000 acres of farmland were converted to urban uses according to Department of Conservation. Even though there is a concern about accelerated urbanization and the subsequent loss of farmland, relatively few private agricultural preservation efforts can be cited in the San Joaquin Valley. The largest regional population centers are the cities of Fresno/Clovis metro area, Bakersfield, and Visalia. Other smaller population centers include the cities of Tulare, Hanford, Porterville, and Delano.

Household incomes and housing prices in the Tulare Lake Region are lower on average, compared to the rest of the state. New jobs in services, industries, construction, and agriculture are generally low-skilled and low-wage jobs, subject to seasonal fluctuation. As a result, unemployment consistently exceeds the state and national rates by as much as 10 percent. According to an April 2004 Public Policy Institute of California (PPIC) special survey, the most pressing issues to the Central Valley for residents of the South San Joaquin survey area were related to population growth and development. They included pollution, 32 percent; economy, 13 percent; population growth, 11 percent; crime, 9 percent; and water, 6 percent. The most notable trend of annual PPIC surveys is the increasing mentions of South San Joaquin residents about air pollution and pollution in general. In 1999, pollution was cited by 9 percent as most important issue, 13 percent in 2001, 19 percent in 2002, 28 percent in 2003, and 32 percent in 2004.

Population density varies widely on a county-by-county basis, and large portions of some counties are virtually unpopulated. Much of the population lives in the more densely developed cities and towns.

Population in the Tulare Lake region was about 1.55 million in 1990 and reached 1.88 million by 2000. This is over a 20 percent growth rate for this 10-year period. Between 1998 and 2000, the population increased more than 3 percent, and California Department of Finance statistics project continued growth rates of 18 percent to 22 percent for these four counties over the next 10 years. Figure 8-2 shows the Tulare Lake region's population from 1960 through 2000, with projections to year 2030.

Land Use

The State and federal governments own about 30 percent of the land in the region, including about 1.7 million acres of national forest, 0.8 million acres of national parks and recreation areas, and 1 million acres of land managed by the U.S. Bureau of Land Management. The region's foothills border Kings Canyon and Sequoia National Parks and Sierra National Forest. Privately owned land totals about 7.4 million acres. Irrigated agriculture accounts for more than 3 million acres of the private land, while urban areas take up over 350,000 acres. Other agricultural lands and areas with native vegetation cover an additional 1.4 million acres.

The climate and soils of the Tulare Lake region contribute significantly to the tremendous production obtained from the land and the diversity of crops grown. Tulare Lake region counties include three of the top five leading California agricultural counties by total value of production. More than 250 crops and farm commodities are produced in the region. While cotton was king for many years, more recently grapes have outpaced cotton in terms of gross receipts. More than 10 percent of the irrigated acreage in California and about 12 percent of the 3 million irrigated acreages in the region is in Alfalfa. Alfalfa acreage in the region has been rising in recent years in response to the demand for quality alfalfa by the expanding dairy industry. Tulare County, in the heart of the region, is the nation's richest dairy county. Deciduous and citrus trees are the main agricultural crops in the lower foothills, while livestock grazing and timber harvesting occur in the higher elevation areas.

The Central Valley constitutes less than 1 percent of the United States farmland but produces 8 percent of total agricultural output. Further, while more than 12 percent of the national gross receipts for farming came from California agriculture's, about 89,000 farms, more than 4 percent of these came from the Tulare Lake region alone. According to the California Department of Agriculture, total statewide agricultural production and gross cash income in 1998 declined 6 percent from 1997, and statewide gross income in 2001 increased 1 percent from 2000. By comparison, agricultural production and cash income in the Tulare Lake region declined to $9.1 billion from 1997 to 1998, which was only a 3.7 percent decrease. Between 2000 and 2001, Tulare Lake region agricultural production increased by 3.4 percent to $9.9 billion.

Some crops and farm commodities that are produced primarily in the Tulare Lake region experienced dramatic increases in export value in 2001. Table grapes, milk and cream, and walnuts all showed double-digit percentage increases in export value from 1998. However, most farm commodities experienced declines in export values between 1998 and 2001. Seven of the top 10 exported crops/commodities declined in value. These included almonds, $760 million to $686 million; cotton, $734 million to $605 million; and wine, $506 million to $491 million.

Water Supply and Use

The region receives most of its surface water runoff from four main rivers that flow out of the Sierra Nevada. They are the Kings, Kaweah, Tule, and Kern rivers. The use of water from these rivers has played a major role in the history and economic development of the region. Major water conveyance facilities for the area include the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal. Water districts in the region have developed an extensive network of canals, channels, and pipelines to deliver developed water to customers. Water storage facilities and conveyance systems control and retain runoff from the watersheds in the region, except in extremely wet years when floodwaters may flow out of the region. During flood years, excess water flows down the north fork of the Kings River toward Mendota Pool and on to the San Joaquin River. In the wettest years, Kings River floodwaters reach the normally dry Tulare Lake via the south fork of the river. Excess runoff from the Kaweah and Tule Rivers might also flow into Tulare lakebed, flooding low-lying agricultural fields. Excess surface water is managed to the maximum extent through artificial groundwater recharge. In the rare event water leaves the basin, it is because the absorptive capacity of the ground water systems in the region has been exceeded. When this happens water is diverted northward and southward through the Kern River intertie into the California Aqueduct to avoid local flooding. Figure 8-3 shows all of the water supply sources used to meet the developed water uses in the region for 1998, 2000 and 2001.

Captured and stored water in many Sierra Nevada reservoirs is used to generate electricity as it is released downstream. Some diversions occur for consumptive use in local communities, but most flows are recaptured in larger reservoirs in the foothills and along the eastern edge of the valley. These reservoirs were built primarily for flood control; however, many of them were also designed to have additional storage capacity for conservation purposes. Canals and pipelines divert much of the water from or below these reservoirs. Smaller communities in the Sierra foothills receive their water from local surface supplies and groundwater. These mountain communities pump groundwater from hard rock wells and old mines to augment their supplies, especially during droughts. Groundwater is the only source for many mountain residents who are not connected to municipal water.

Major statewide water projects in the Tulare Lake Region include the State Water Project's California Aqueduct, which has a state/federal joint use portion known as San Luis Canal. The aqueduct is along the western side of the valley. Sacramento-San Joaquin Delta water is brought into the region through the California Aqueduct. CVP water is also sent down from the Delta through the San Luis Canal to agencies with federal entitlements on the west side of the valley, such as Westlands Water District. The CVP's Friant-Kern Canal runs south along the eastern side of the valley and transports San Joaquin River water to agencies along the valley's eastern side and Kern County. The Friant Unit of the CVP also diverts water northward from Millerton Lake via the Madera Canal.

The SWP provides an average of 1.2 million acre-feet of surface water annually to the region, which is used for both agricultural and urban purposes. The U.S. Bureau of Reclamation supplies an average of 2.7 million acre-feet from the CVP via Mendota Pool, the Friant-Kern Canal, and the San Luis Canal, primarily for agricultural uses. Actual deliveries to contractors vary from year to year based upon a number of factors, primarily hydrologic conditions in Northern California. Other factors include equipment malfunction, natural disasters, timing of infrastructure development, and environmental challenges.

Groundwater has historically been important for both urban and agricultural uses. It accounts for 33 percent of the region's total annual supply and 35 percent of all groundwater use in the State. Additionally, the region's groundwater represents about 10 percent of the State's overall supply for agricultural and urban uses. Most towns and cities along the east side of the valley, including Fresno, Visalia and Bakersfield, rely primarily on groundwater. Bakersfield occasionally obtains supplemental water from local surface water and some imported water. Fresno, Visalia, Bakersfield and other cities also have groundwater recharge programs to help ensure that groundwater will continue to be a viable water supply. On the valley's western side, smaller cities like Avenal, Huron, and Coalinga rely on imported surface water from the San Luis Canal to meet municipal demands. This surface water replaces groundwater of poor quality.

In addition to the recharge programs employed by some valley cities, extensive groundwater recharge programs (known as water banks) are also in place in the south valley where water districts have recharged several million acre-feet of surplus water for future use and transfer through water banking programs. For more than100 years, water supply and irrigation districts throughout the region have used conjunctive use to maximize water supply and maintain the groundwater system. Other conjunctive use used throughout the valley include water exchange and transfer programs.

Table 8-1 presents a water balance summary of the Tulare Lake region. A comparison of regional urban, agricultural and environmental water uses indicates that urban water use is about 5 percent, agricultural water use is 84 percent and environmental water use is about 11 percent of the developed water supplies. Figure 8-4 shows the dedicated and developed urban, agricultural and environmental water uses in the region for 1998, 2000 and 2001.

Many different crops are grown throughout the region. Most of the agricultural land in the region lies in organized water districts. Many water districts in recent years have actively been changing water management practices and physical structures to improve the efficiency of water delivery and use.

Urban water use accounts for about 5 percent of the total applied water in the region. Many of the communities in the region that are served by agency-produced water are not metered, and customers are charged a flat rate for water use. However, urban communities are gradually working towards the installation of water meters as funding allows. State legislation, AB 514 (Kehoe), signed into law in October 2003, requires all California cities that receive water from the CVP to install and use water meters. Some of the larger cities that are affected include Sacramento, Folsom and Fresno. In Fresno, the new law is being viewed as a solution to a longstanding problem. It is believed that AB 514 will remove the requirement for Fresno to obtain voter approval to amend its charter to permit metering. The U.S. Bureau of Reclamation and the federal Department of Interior have made the installation of water meters a requirement, if Fresno plans to renew its CVP contract for 60,000 acre-feet of surface water from the Friant Division.

The variability of industrial water use is a function of economic, climate, and technological factors. Agriculture harvest schedules have a large effect. Local water agencies supply water to most of the smaller industrial facilities in the cities. However, larger industrial and institutional water users both inside and outside urban areas generally develop their own ground water supplies or divert from local streams. Higher per capita water use in areas like Fresno and Bakersfield are generally due to their higher concentration of these industries. In the case of Bakersfield, the oil and food processing industries are a large segment of the total industrial water use activity.

Water Recycling

In the Tulare Lake region, discharge of recycled water is regulated through the Regional Water Resources Control Board as identified in the Board's Tulare Lake Basin Plan. The significant increase in population in the Tulare Lake Region has resulted in a rising volume of recyclable water. This has forced municipalities to reassess collection, transmission and treatment capacities of their wastewater plants to handle increasing volumes. Most of the recycled water in the region is used for irrigation and groundwater recharge. The rest is evaporated. There are several cities, such as Bakersfield, that have built recycled water delivery systems for agricultural irrigation use. When effluent is discharged, a discharge permit must be obtained as part of the EPA National Pollutant Discharge Elimination System (NPDES). Permitting Program. Water reuse in the Tulare Lake Region is estimated to be over 150,000 acre-feet in 2000. Groundwater recharge programs account for more than half of all recycled water used.

State of the Region

Challenges

Whenever a region looks outside of its borders for more water, statewide water management and integrated resource planning come into the picture. Depending on the package of options chosen, one region's actions can affect another region's supplies. Statewide planning involves assessing trends in each region's water demand and quantifying the cumulative effects of each region's demand and use patterns on statewide supplies. It basically parallels planning at the local and regional levels. By working through a statewide planning process, the magnitude of both intra- and inter-regional effects can be analyzed. However, in a number of circumstances, measures that would be taken to manage demand, to increase supplies, or to improve water service reliability are local decisions. These decisions must weigh the cost of increased reliability with the economic, environmental, and social costs of expected shortages.

In the short term, those areas of California that rely on the Sacramento – San Joaquin Delta for all or a portion of their surface water face an unreliable supply due to the evolving protections of aquatic species and water quality. At the same time, California's water supply infrastructure is severely limited in its capacity to transfer marketed water through the Delta due to those same operating constraints. Until solutions to complex Delta problems are identified and put in place and demand management and supply augmentation options are implemented, some water dependent regions will experience imported water shortfalls. Such limitations of surface water deliveries will exacerbate groundwater overdraft in the Tulare Lake region because groundwater is used to replace much of the shortfall in surface water. In addition, water transfers within these areas have and will become more common as farmers seek to minimize water supply effects on their operations. In urban areas, water conservation and water recycling will be accelerated to help offset short-term water needs. Proposition 50, also known as "Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002," provides the mechanism for funding projects to augment systems and supplies, optimize delivery systems, use recycled water and increase water management efficiency.

Unique environmental water needs exist for each of the four major watersheds in the Tulare Lake Hydrologic Region which encompass the river systems of the Kings, Kaweah, Tule and Kern. There has been significant activity on both the Kings and Kern Rivers to restore flows for habitat as well as recreation. Modification to outlet structures and timing of releases on the Kings River provide cooler water temperatures to protect the resident trout populations. Gravel augmentation is also carried out to provide spawning habitat as well. The Kern County Water Authority has implemented a successful and innovative program of delivering supplies down the river through the City of Bakersfield for instream uses and then extracting the water farther downstream through the use of wells. Environmental water supplies on the Kaweah and Tule Rivers are being modified due to the mitigation requirements tied to reservoir enlargement projects on both systems.

Groundwater pumping, a major source of supply in the Tulare Lake region, continues to increase in response to growing urban and agricultural demands. If groundwater extraction continues to be used to offset anticipated but unmet surface water imports, it will have negative consequences. One such effect of long-term groundwater overdraft is land subsidence, which also results in a loss of aquifer storage space. This has already caused some damage to canals, utilities, pipelines, and roads in the region. In an effort to slow this condition, many water agencies have adopted groundwater replenishment programs and have taken advantage of excess water supplies available in wet years, incidental deep percolation, and seepage from unlined canals.

Salinity is the primary contaminant affecting water quality and habitat in the Tulare Lake region, a consequence of agriculture compounded by groundwater overdraft. Agricultural runoff and drainage are also the main sources of nitrate, pesticides, and selenium that endanger groundwater and surface water beneficial uses. The basin also has a relatively large concentration of dairies that contribute microbes, salinity, and nutrients to both surface water and groundwater. Nitrate has contaminated more than 400 square miles of groundwater in the Tulare Lake Basin. In addition, more than 800 oilfields discharge a wide variety of contaminants to the waters of the region.

On the region's west side, salinity, sulfate, boron, chloride, and selenium limit the uses of groundwater. Where groundwater quality is marginal to unusable for agriculture, farmers use good quality surface water to irrigate crops, or blend higher quality surface water with poor quality groundwater to create a larger supply. The inefficiency of some crop irrigation systems can increase percolation of irrigation water into the shallow unconfined aquifers, causing drainage problems and degrading groundwater quality. This marginal to poor quality groundwater has mounded up to reach crop root zones in this area and is threatening the viability of agriculture there.

Naturally occurring arsenic and man-made organic chemicals--pesticides and industrial chemicals--have contaminated groundwater used as domestic water in the region. For example, the lone well that provides water for city of Alpaugh's 760 residents — 40 percent live in poverty — contains unsafe levels of naturally occurring arsenic. By 2006, new federal and State rules will force more than 50 central San Joaquin Valley communities, including Hanford, Pixley, and Tranquility, to cut arsenic levels to one-fifth the current allowable levels. The closing of 40 wells in Fresno due to high levels of dibromochloropropane (DBCP), trichloroethylene (TCE), and other organic compounds required the installation of activated charcoal filtration systems to remove these contaminants.

The quality of local surface water from the Kings River and the San Joaquin River (diverted south through the Friant-Kern Canal) is excellent for irrigation, and municipal and industrial uses. The Central Valley Regional Board did, though, specifically identify salinity in the lower Kings River as a priority in its 2002 Triennial Review. On the west side of the region, DWR has sought solutions to the flooding on the Arroyo Pasajero, which threatens the California Aqueduct. The aqueduct, which forms a barrier to arroyo floodwaters and sediment flow, is at risk of failure during major rainstorms in the watershed. Also, the asbestos in the arroyo sediment load that enters the aqueduct during floods has raised questions of possible health risks. Both Panoche and Silver creeks contribute large sediment loads to the aqueduct and the valley floor; Panoche Creek also has elevated levels of selenium.

For many years, the Tulare Lake region has included areas with significant drainage problems. The need for proper drainage has long been recognized by federal and State agencies. Planning for drainage facilities to serve the San Joaquin Valley began in the mid-1950s. The poorly drained area is concentrated along the western side of the San Joaquin Valley from Kern County north into the San Joaquin River Hydrologic Region. Although the San Joaquin Valley has some of the most productive agricultural lands in the world, much of the west side of the valley is plagued by poor subsurface drainage that adversely effect crop productivity. Between 1977 and 1991, the area affected by saline shallow groundwater on the west side doubled to about 750,000 acres. At present, a substantial portion of the valley, about 2.5 million acres, is threatened by saline shallow groundwater.

In addition, the drainage water is sometimes contaminated with naturally occurring, but elevated, levels of selenium, boron and other toxic trace elements that threaten the water quality, environment, and fish and wildlife. Water planners had originally envisioned a master surface water drain to remove this poor quality water, but that proposal was never implemented. The U.S. Bureau of Reclamation has an obligation to provide agricultural drainage service to farm lands served by the CVP on the west side of the valley. To convey this sometimes contaminated drainwater more directly to the San Joaquin River and away from the sensitive San Luis National Wildlife Refuge Complex, a portion of the San Luis Drain was reopened in September 1996 as part of the Grassland Bypass Project. The San Luis Drain was modified to allow drainage through six miles of Mud Slough, a natural waterway that passes through the San Luis National Wildlife Refuge Complex and a section of the North Grassland Wildlife Area.

The monitoring of San Joaquin Valley agricultural drainage water began in 1959 as a cooperative agreement between the Department of Water Resources and the University of California. In 1984, the San Joaquin Valley Drainage Program was established as a joint federal and State effort to investigate drainage and drainage-related problems and identify possible solutions. In September 1990, the San Joaquin Valley Drainage Program summarized its findings and presented a plan to manage drainage problems in a report titled *A Management Plan For Agricultural Subsurface Drainage and Related Problems in the Westside San Joaquin Valley.* In December 1991, several federal and State agencies signed a memorandum of understanding, and released an implementation strategy titled *The San Joaquin Valley Drainage Implementation Program*. The purpose of the 1991 MOU and its strategy document was to coordinate various programs in implementing the 1990 recommendations.

In 1997 a plan was initiated by the member agencies of the San Joaquin Valley Drainage Implementation Program and the University of California to review and evaluate the 1990 Plan and update its recommendations. Eventually, the San Joaquin Valley Drainage Authority, which includes districts in the Grassland, Westlands, and Tulare subareas, was formed to develop a long-term solution for drainage problems in the valley, which could include out-of-valley disposal. Studies continue in pursuit of cost-effective ways to dispose of the drainage water.

In 2002, the U.S. Bureau of Reclamation released the San Luis report, which declared that an “in-Valley” solution to the drainage problem on the valley’s west side should be implemented. The proposed alternative includes the following features: a drainwater collection system, regional drainwater reuse facilities, selenium treatment, reverse osmosis treatment for the Northerly Area, and evaporation ponds for salts disposal.

Also in 2002, the Westlands Water District, and the United States reached a settlement regarding drainage that the U.S. was legally bound to provide to west side farmers. As a result of this agreement, the number of acres requiring drainage service in the San Luis Unit will initially be reduced by retiring about 33,000 acres, part of a proposal to retire up to 200,000 acres.

Accomplishments

Many water districts in recent years have actively been trying to improve water delivery and use efficiency. About 14 individual water districts encompassing more than 1.3 million acres have become signatories to the Agricultural Water Management Council and have prepared Agricultural Water Management Plans. In addition, many water districts are working with growers to improve on-farm water management systems. This assistance includes providing irrigation scheduling information, assistance in obtaining low interest loans, water trading, delivery augmentation and irrigation system evaluations.

On the western side of the San Joaquin Valley, particularly in Fresno and Kings counties, farmers are using more sprinkler irrigation and less flood, basin, or furrow irrigation, reducing incidental deep percolation, a very beneficial source-control measure in the areas with challenging high water tables. In addition, improved management of the remaining furrow and basin irrigation and cropping are showing success. In 1998, less than half of the irrigated land was flood irrigated.

Many farmers use sprinklers and drip irrigation, especially on truck crops where small applications of water early in the growing season are very beneficial. The amount of water applied during the pre-irrigation of cotton and other crops has been significantly lowered via increased use of sprinklers. Buried drip irrigation systems have been increasing in acreage, as the proper equipment and designs are proven successful. Also, almost all new plantings and replanting of orchards and vineyards use drip or micro-sprinkler irrigation systems and many older plantings are being converted from furrow or basin systems, where conditions are favorable for success. As trees and vines age, their yields decrease to a point where returns are no longer profitable and must be replanted. Thus, eventually nearly all trees and vines with conditions favorable to their use in the region will be irrigated with micro-irrigation.

The Department of Water Resources conducted a survey of irrigation methods being used to irrigate crops in Kern County in conjunction with its summer land use survey performed in 1984 and 1998; see table 8-2, below. In general, adoption of micro-irrigation systems has increased dramatically in all permanent crop plantings over this period. For example, the truck crop category changed from no micro to almost 5 percent.

Table 8-2
Percentage of Acreage of Each Crop Category by Irrigation Method used – Kern County

	1984	1998	1984	1998	1984	1998
	SURFACE		SPRINKLER		MICRO	
GRAIN	52.1	46.1	47.9	53.9	0.0	0.0
FIELD CROPS	63.9	77.2	36.1	22.8	0.0	0.0
ALFALFA	77.2	88.3	22.8	11.7	0.0	0.0
PASTURE	76.9	81.7	23.1	18.3	0.0	0.0
TRUCK CROPS	17.4	24.9	82.6	70.5	0.0	4.6
DECIDUOUS ORCHARD	41.9	29.9	27.2	6.1	30.9	64.0
SUBTROPICAL	13.8	2.8	23.4	0.6	62.8	96.6
VINEYARD	59.2	36.1	15.7	1.8	25.2	62.1

In general, management of irrigation systems, including non-pressurized irrigation systems, such as furrow and basin, has been improving. Economic pressure has caused increasing farm efficiency. The pressures include, higher production costs, higher utility rates, and low crop prices. Inconsistent year to year contract deliveries from the CVP and SWP have also motivated farmers to improve efficiency. Farmers are using a wider availability of crop irrigation scheduling information and soil moisture monitoring programs to respond to these pressures. Public outreach and training efforts by the U.C. Cooperative Extension, irrigation districts and others has made this possible. Finally, as agricultural production continues to experience a price-cost squeeze, farming throughout the region is tightening the use of all production inputs, including water by improving irrigation management based on better knowledge of crop evapotranspiration requirements and soil moisture needs, and nutrient management.

Efforts to improve water use in the urban sector began earnestly during a six-year drought, which began in 1987. The California Urban Water Conservation Council was created in 1991 by the signing of the "Memorandum of Understanding Regarding Urban Water Conservation in California." The CUWCC is composed of urban water agencies, public interest organizations, government and private entities. Together these organizations work to promote efficient water use statewide. Many water and utility companies throughout the state offer financial and technical assistance programs that specifically help those who are on a limited budget to implement water and energy efficiency improvement in their homes.

The water agencies in the Tulare Lake region that have submitted urban water management plans are : West Kern Water District, North of the River MWD, East Niles Community SD, Oildale Mutual Water Company, Vaughn Water Company, city of Bakersfield, city of Corcoran, city of Lemoore, city of Reedley, city of Hanford, Kern County Water Agency and City of Sanger. Of these agencies, the city of Sanger and Kern County Water Agency have approved urban water management plans.

Regarding groundwater, the Groundwater Management Act, AB 3030 (California Water Code Section 10750 et seq.) allows certain defined existing local agencies to develop groundwater management plans. Groundwater basins are explained and defined in DWR Bulletin 118. Under AB3030, no new level of government is formed and action is voluntary. Prior to AB 3030, the Water Code was amended by AB 255 in 1991 to allow local agencies overlying critically overdrafted groundwater basins to develop groundwater management plans. There are six water agencies in the Tulare Lake region that prepared groundwater management plans under AB 255. Following AB 3030 legislation, 26 groundwater management plans have been adopted in the region.

Cities and counties are continually introducing new technology while maintaining, servicing, expanding, and updating their water systems. After years of violating state drinking water standards for taste and smell, the city of Mendota, in western Fresno County, will be bringing a new water system online. Three new wells east of the city have been built, each with the capacity to pump up to 1,500 gpm. The supply is transported to the city’s treatment facility via a 20-inch pipeline, where a filtering tank has been added to the three that exist at the water purification plant.

The California Revolving Fund program disburses low interest loans to address water quality problems associated with discharges from wastewater and water reclamation facilities, as well as from non-point source discharges and for estuary enhancement. This policy was written to implement the 1987 Amendments to the Federal Clean Water Act which created the State Revolving Fund (SRF) Loan Program. Participants in the Tulare Lake Region include: (1) the town of Alpaugh with a treatment and collection system; (2) the city of Fresno, treatment plant expansion; (3) the county of Kern, the Rexland Acres community sewer collection and transmission system; and (4) the Fresno Metropolitan Flood Control District, stormwater quality management.

The city of Clovis received AB 303 funding for a proposed project that will include: (1) compiling groundwater recharge basin site characteristics to increase recharge capabilities, (2) constructing groundwater monitoring wells at recharge facilities to better monitor percolation and movement, and (3) creating a Ground Water Information System (data management system) to provide a comprehensive and organized data base for improved groundwater data accessibility and maintenance.

In Kern County, the Kern Water Bank Project will receive Proposition 13 funding to increase the recovery capacity of the Kern Water Bank. The Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program will receive Prop 13 funding to provide additional opportunities for Kern County facilities to capture and transport high-flow water supplies and may provide water for ecosystem restoration and the Environmental Water Account.

Another project receiving Prop 13 funding is the Kern Water Bank River Area Recharge and Recovery Project that would allow the Kern Water Bank Authority to provide as much as 50,000 acre-feet per year of additional water recovery capability. In years when recovery needs are less than recovery capacity, water could be recovered for the Environmental Water Account or other ecosystem restoration needs.

The North Kern Groundwater Storage Project will take advantage of wet-year high flows and store them in the groundwater aquifer. This may reduce demands on water supplies from the Delta in dry years.

The Westlands Water District received AB 303 funding to find more water, including potential conjunctive use opportunities. The project was completed in 2002. The investigation included three deep soil-boring and a monitoring well installed by DWR to evaluate the storage, water quality, and extraction potential of the aquifer. AB 303 paid for the installation of 35 shallow borings to evaluate the percolation potential of the uppermost sediments. The study recommended the area where Arroyo Pasajero intersects with Interstate 5 as a site for conjunctive use groundwater application.

Within the past several years, Broadview Water District announced that landowners had decided to sell the District due to the increasing costs of production and the additional costs associated with the District's drainage and salinity problems.

In 2003, the Pajaro Valley Water Management Agency and Broadview Water District began negotiating the sale. Pajaro Valley WMA had prepared the necessary paperwork and completed the required studies; unfortunately, negotiations never culminated in an agreement that was acceptable to both parties. At about this time, Westlands Water District, which shares part of its northern district boundary with Broadview, began negotiations with the District. Westlands announced the following in a District notice to landowners in September,

> "Negotiations have been completed for Westlands to purchase the Broadview Water District. The acquisition encompasses all the Broadview lands and includes the district's 27,000 acre-foot CVP water service contract.
>
> The sales/purchase agreement is being circulated among Broadview landowners for their approval, and the transaction is expected to be completed by February 28, 2005. District staff has also met with Fresno County LAFCO to discuss annexing the Broadview lands into Westlands."

For some time now, Westlands WD has been attempting to “augment” its water supplies by selling lands suffering severe drainage problems and using the water entitlements retained from these lands to firm up the entitlements to the remaining irrigated lands in the District. The impending purchase of Broadview Water District and its concomitant CVP water entitlement is another avenue in this direction.

In western Fresno County, the Natural Resources Conservation Service is promoting programs that:

(1) reduce the amount of salts leached to ground water and improve shallow, saline water table conditions with improved irrigation water management
(2) improve the distribution and management of livestock to reduce erosion using prescribed grazing, fencing, and improved watering facilities for livestock
(3) reduce soil salinity in the crop root zone to improve cropland productivity with improved irrigation water management and soil salinity management
(4) reduce the amount of airborne particulates with adjusted timing of agricultural operations, vegetating turn areas, and avoiding tracking soil onto the county roads
(5) reduce sheet and rill erosion on rangeland through improved livestock distribution and production of forage.

The Lake Kaweah Enlargement Project will raise the Lake Kaweah spillway by 21 feet and increase the lake’s water storage by 143,000 acre-feet to 183,000 acre-feet, or 28 percent. Still a small lake in comparison to others in California, the enlargement project will increase flood protection to downstream communities on the Kaweah Delta river system, especially Visalia. The dam’s spillway crest, a U-shaped cut, is being raised with the installation of "fuse gates." These gates are like large concrete teeth that pop out like fuses if the lake should become so full. Once completed, farmers should reap immediate benefits because a larger lake will allow longer summer-irrigation periods. Additionally, the Tulare Lake lakebed is less likely to be inundated with flood flows that could halt farming operations. Recreational use will also be enhanced, because even in winter, when the lake is almost empty, it will be large enough for boating. The federal government is putting up more than half the cost of the $33 million project, the state Reclamation Board is providing $10.1 million, and the local agencies are providing $5.4 million.

The Coordinated Resource Management and Planning (CRMP) groups in the Tulare Lake Basin region include the Panoche/Silver Creek CRMP, the Stewards of the Arroyo Pasajero Watershed CRMP, and the Cantua/Salt Creek Watersheds CRMP. Their aim is to promote watershed health throughout the western Fresno county foothills. The primary concerns in these watersheds are flooding, erosion, sediment transport and the quality of water entering into the San Joaquin River and the California Aqueduct. Some of the water management strategies they employ to address these problems include stream flow and water quality monitoring programs, re-vegetation of embankments, and implementation of watershed best management practices.

As part of the Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program, the Kern River Parkway will include a 40-acre multipurpose recharge lake and recreation area with a permanent 10-acre recharge lake and adjoining playing field that will be surrounded by grassy slopes and tree-shaded seating areas. During extremely wet water years, these open 25-acre fields will be flooded and used for groundwater recharge in the spring. There will also be a new access route to the existing Kern River north bank equestrian trail from the future Jewetta Avenue extension.

Relationship with Other Regions

The Tulare Lake region receives CVP water from the San Joaquin River Region via the Friant-Kern Canal, and imported water from the Sacramento-San Joaquin Delta via the SWP California Aqueduct and the CVP San Luis and Delta-Mendota canals. The economic health of the region heavily depends on the availability of imported surface water to meet future needs.

Looking to the Future

Ongoing Planning

- Kern County Water Agency Conjunctive Management Program
- Water Agency Exchanges and Transfers
- Kern County Water Agency EWA Sales
- Optimization of Water Conveyance Systems
- Inter-regional Water Storage, Drought Supply Agreements

The counties in the Tulare Lake Region have water agencies that have been proactive for many years. Water from local streams has been developed for agricultural and urban use. In addition, when it became apparent that the groundwater would run out, many agencies worked to get the CVP and SWP approved and completed. The predominantly agricultural economy has been slowly adapting to share with the growing urban economy. New projects have been identified as necessary to better manage the local water supplies, adhere to more stringent water quality standards and environmental regulations.

Regional Planning

An important piece of California's water puzzle is the voluntary transfer of water from one water user to another. A rather brisk business in water transfers has developed in the lower San Joaquin Valley. Local rules allow districts through groundwater banking agreements or other joint water development projects to transfer water.

The San Joaquin Valley Water Coalition meets to discuss common issues related to water supply, water quality, and water management to ensure the reliable distribution of water.

Some factors that must be considered in regional planning are:

- Population growth
- Groundwater overdraft and associated problems
- Reliability of supplies in foothill and mountain communities
- Reliability of supplies for wildlife and the environment
- Transfers and exchanges and their effects
- Groundwater banking programs
- Groundwater quality, issues particularly for drinking and municipal use

Several projects resulting from this planning are listed below.

Pond-Poso Improvement District Project Enhancements

The Pond-Poso Improvement District is working to improve the groundwater resource in the north-central Kern County. The district recently qualified for Proposition 204 funds. A primary goal is to encourage local groundwater users to begin using surface water whenever available instead of groundwater, which helps the groundwater basin. The project is being done by the Semitropic Water Storage District.

Pioneer Groundwater Recharge and Recovery Project

The funding obtained from Proposition 204 will be used to enhance the Kern Water Bank. The project aims to maximize recovery of recharged groundwater so it can be used by those participating in the project. The project has the potential to reduce dry-year demands for water from the Delta. The Kern County Water Agency is the recipient of the Prop. 24 funding.

Pond - Shafter - Wasco Irrigation and Water Use Efficiency

This effort is targeting agricultural irrigation in Kern County. The project's goals are to: 1) implement a Total Farm Management Program in the San Joaquin Valley area of Kern County, 2) reduce PM-10 levels on 50 percent of the permanent crops harvested in the valley, 3) reduce agricultural water use by 15 percent over the next five years through changes to irrigation systems and irrigation management, 4) increase wildlife habitat by 30 percent over the next five years 5) educate local growers about new or proven techniques in water, air, nutrient, and pesticide management. The Pond-Shafter-Wasco Resource Conservation District and the Natural Resources Conservation Service are leading this project.

Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program

Proposition 13 funding will be used to provide additional opportunities for Kern County to develop water supplies for local uses, increase opportunities for ecosystem restoration, and increase sales to the Environmental Water Account. The Kern County Water Agency is the grantee.

White Wolf Basin Groundwater Banking Project

The White Wolf Basin is a small, somewhat isolated, groundwater basin in the southeastern corner of Kern County. The Wheeler Ridge-Maricopa Water Storage District is studying groundwater banking in the aquifer. Water from the California Aqueduct would be imported for storage. Recovered water could be conveyed back to the aqueduct, or introduced into the district's distribution system and exchanged for SWP water. Pilot wells are being drilled in order to better understand the geology of the basin.

South Valley Water Management Program

The southern end of the San Joaquin Valley has water conveyance that is interconnected, especially in Kern County. During wet years water can become available for short durations from any of a number of sources, including the San Joaquin River, Kings River, Kern River. The Kern County Water Agency and several south valley water districts are studying whether to coordinate supplies and deliveries.

Rosedale-Rio Bravo Water Storage District Banking Program

The Rosedale-Rio Bravo Water Storage District (RRB) is developing a banking project with a maximum storage of 500,000 acre-feet. Recharge basins and recovery wells are being built. Generally, RRB will store water for others in wet years via 2-for-1 exchanges and return water in drier years either by delivery of its SWP or Kern River water, or by pumping wells if there is insufficient exchange.

Kern Delta Water District/Metropolitan Water District Joint Banking Project

Kern Delta Water District is developing a banking partnership with the Metropolitan Water District. MWD will store water in Kern Delta in wet years and recover the water during drier years. The project is similar to the joint Arvin-Edison/Metropolitan Water District Program. The program contemplates storing a maximum of 250,000 acre-feet of water for MWD.

Other long-term programs and activities involved in future options being considered in the region include:

- Increased agricultural water use efficiency
- Increased urban water use efficiency

- Water conservation
- Land retirement
- Temporary fallowing
- The Kern Water Bank and similar projects
- SWP water supply augmentation
- CVP supply augmentation
- Mid-Valley Canal or similar project
- Demand reduction
- Short-term water transfers
- Gray water use
- Water recycling.
- Local conjunctive use
- Groundwater reclamation
- Reuse of brackish agricultural drainage water

Water Portfolios for Water Years 1998, 2000 and 2001

Detailed information on the water portfolios for 1998, 2000, and 2001 is presented in tables 8-3 and 8-4 and figures 8-5, 8-6, and 8-7.

Water Portfolio - Water Year 1998

California weather and water were affected by another El Nino event during 1997-1998 water year. The previous El Nino was 1991-1992. El Nino storms did not begin earnestly until January 1998, upon arriving they raised havoc on a number of crops. Of California's 58 counties, 42 were declared major disaster areas.

As a result of the very wet weather, agriculture throughout California delayed crop planting, and produce was damaged. Consumers felt the impact of high supermarket prices for California vegetables. Producers had difficulty getting into their soggy fields. Normal farming practices, such as spraying, pruning, and tying vines were delayed. The quality of many crops was below normal. Fortunately for late-developing crops, the fall weather had clear skies and good temperatures, allowing the majority of crops to be harvested with no additional weather problems.

Watershed runoff was well above normal, as the San Joaquin and Kings rivers averaged about 170 percent of normal, the Kaweah River about 196 percent and the Kern River was about 224 percent.

Total irrigated acreage in the region rises and falls depending on surface water availability from local and imported sources in any particular year. The 1998 total irrigated acreage was 3.214 million acres. The trend in individual crop acreages is toward higher value commodities such as fruits, tree nuts and vegetables, while the acreage of field crops has been declining. Acreage of wine grapes has been rapidly growing, and almond acreage also continued its steady trend upward.

The dairy industry continued its growth in 1998, particularly in Tulare County, which is now the top milk-producing county in the nation. Alfalfa acreage in the Tulare Lake region exceeded 360,000 acres in 1998, up from 279,600 acres reported in 1995. Corn acreage has risen even faster than alfalfa, exceeding 257,000 acres in the region in 1998, driven by the increasing demand from the dairy industry.

Cotton acreage was down substantially due primarily to El Nino, decreasing to 655,400, a 35 percent decrease from 1995. Thus, growers continued the trend of converting field crop land to almond/pistachio orchards in an effort to provide better long-term profits. A combined almond/pistachio acreage of 245,700 acres was 32 percent higher than the acreage reported in 1995.

El Nino storms provided an extra source of water, filling soil profiles and reducing early season ETAW, consequently, less applied water was needed compared to most years. The total agricultural on-farm applied water estimated for the Tulare Lake region was 7 million acre-feet, and total agricultural water use was 8.6 million acre-feet or 69 percent of all uses. The regional average agricultural on-farm unit AW was 2.2 acre-feet per acre.

The total agricultural evapotranspiration of applied water, or ETAW, in 1998 in the region was 5.2 million acre-feet. The regional average unit ETAW was 1.6 acre-feet per acre. Individual crop ETAW amounts vary due to differences in rainfall, growing season, soil texture and rooting depths.

Total urban applied water use, including residential, commercial, industrial, and landscape, in the region totaled 546,100 acre-feet. Urban water use accounted for about 5 percent of the total applied water in the region. Population of the region in 1998 was 1,816,440. Total urban ETAW for the year was about 187,000 acre-feet and the regional average per capita water use was 268 gallons per day.

Total environmental demand – for instream, wild and scenic, and refuges – for the region was about 3.3 million acre-feet. This accounts for 26 percent of total uses. This includes water that is reserved for instream and wild and scenic river flow, but that can be later used as a supply by downstream users. Refuge supplies, which are supplies applied directly onto wildlife refuges, accounts for 63,100 acre-feet.

Total supplies, including local and imported CVP and SWP surface water, groundwater, and reuse, amounted to 12.4 million acre-feet.

Water Portfolio - Water Year 2000

The weather for water year 1999-2000 in the Tulare Lake Region was very close to the long-term average. Rainfall was somewhat less than average in the southern areas of the region, where Bakersfield received 81 percent. It was somewhat higher than average in the northern areas of the region, where Fresno received 120 percent of normal. Runoff was about 101 percent of average from both the San Joaquin and Kings rivers , about 87 percent of average from the Kaweah River and about 70 percent of average from the Kern River.

Acreage increased only slightly from 1998 to 2000 within the region to 3.219 million acres. The largest crop acreage change was in cotton, which increased 10.7 percent to 725,300 acres in 2000. Cotton prices continued to be low, however, while grower production costs have been rising. The 2000 combined almond and pistachio acreage of 257,000 was 11,200 acres, or 4.6 percent higher than in 1998. Corn acreage, primarily for silage, declined 10 percent.

The total agricultural on-farm applied water in 2000 for the Tulare Lake region was 9.7 million acre-feet, a significant 38 percent increase over 1998. The large difference illustrates the degree to which weather, particularly wet and cool conditions, can have on irrigation demand and acreage. 1998 was a very wet and cool -- low evaporative demand -- year, reducing irrigation demand dramatically. The total agricultural water use was 10.8 million acre-feet or 84 percent of all uses and 26% more than 1998. The regional average agricultural on-farm unit applied water was about 3.4 acre-feet per acre.

The total agricultural ETAW in the region was about 7.2 million acre-feet, or 38 percent higher than that of 1998. The regional average unit ETAW was 2.2 acre-feet per acre.

The dairy industry continued its strong growth. New records were set for the number of milk cows and milk production. In 2000, California led the nation in total milk production with a record 32.2 billion pounds, representing a 6 percent increase from the previous year.

In 2000, total urban applied water for the region was 653,400 acre-feet, which was about 20 percent higher than the total applied water for 1998. Urban water use accounted for more than 5 percent of the total applied water in the region. Total population in 2000 within the region was 1,884,650, an increase of 3.8 percent over the 1998 population. Average per capita water use was about 310 gallons per day. Total urban ETAW for the year was about 223,300 acre-feet, an increase of 19% from 1998.

Total environmental demand for instream, wild and scenic, and refuges for the region was about 1.4 million acre-feet, 57% less than 1998. This accounts for 11 percent of total uses. This includes water that is reserved for instream and wild and scenic river flow, but that can be later used as a supply by downstream users. Refuge supplies, which are supplies applied directly onto wildlife refuges, accounts for 73,800 acre-feet.

Total supplies, including local and imported from the CVP and SWP surface water, groundwater, and reuse, amounted to about 12.9 MAF, 4% less than 1998.

Water Portfolio - Water Year 2001

The water year started out cooler than normal with cumulative rainfall below average through most of January. However, large scale weather patterns changed significantly as February approached and a series of Pacific storms moved into the state, helping to bring precipitation totals closer to normal. Rainfall amounts were slightly less that average for the water year in the region with totals in both Fresno and Bakersfield about 93 percent of average.

Except for a thunderstorm in April resulting in significant high wind, hail, and rainfall, crop development was generally normal throughout the remainder of the growing season.

Less than ample precipitation in local watersheds resulted in runoff for the year being below average resulting in below-average surface water supplies. Runoff from the San Joaquin, Kings, and Kaweah Rivers was about 71 percent of average , while runoff from the Kern River was 54 percent of average.

Total irrigated agricultural acreage was 3.09 million acres, a decline of 9.6 percent or 126,000 acres from 2000. The price for milk and cream commodities rose 14 percent in 2001 and pushed Tulare County into the leading agricultural commodity gross value position among all California counties, surpassing Fresno County, which had held the number-one position for many years. Cotton acreage was 639.400 acres, 85,900 fewer acres than in 2000, influenced primarily by the drop in price of the upland variety. Sugar beets acreage continued its multiyear downward spiral at 15,100 acres, 47 percent less acreage than in 2000. The transition into wine grapes over the past several years leveled out as the market reached a point of saturation and prices began to weaken. The acreage of raisin grapes dropped almost 20 percent in 2001 responding to the dramatic drop in price over the past couple of years. Raisin growers had received more than $1,000 per ton in 1999 compared to about $525 per ton in 2001. The almond/pistachio acreage followed the upward trend of previous years increasing over 10 percent.

The total agricultural on-farm applied water in 2001 for the Tulare Lake region was 9.9 million acre-feet, and total agricultural water use was 10.6 million acre-feet or 86 percent of all water uses, 23 percent more than 1998 but 2 percent less than 2000. This is an average unit rate of 3.4 acre-feet per acre. The total agricultural ETAW in the region was 7.3 million acre-feet, about 41 percent higher than 1998 and 2 percent higher than 2000.

The total urban applied water in 2001 for the region was 677,800 acre-feet, which was 24 percent higher than 1998 and 4 percent higher than 2000. Urban water use accounted for about 5.5 percent of the total applied water in the region. Total population in the region for 2001, was 1,921,915, an increase of 2 percent than 2000 population and 5.7 percent higher than 1998. Average per capita water use about 315 gallons per day. Total urban ETAW for the year was about 232,400 acre-feet, an increase of 24% from 1998 and 4% from 2000.

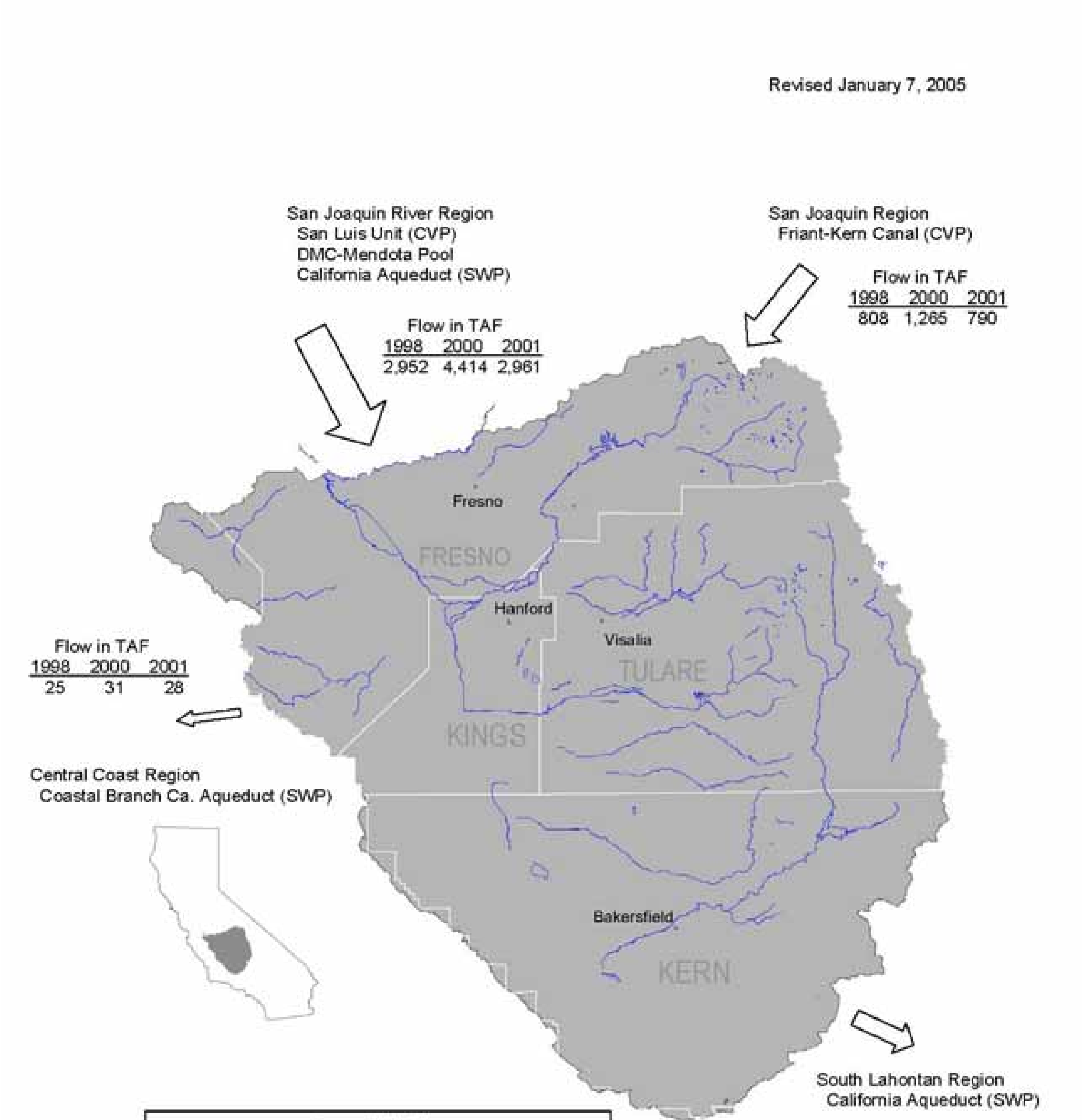
Total environmental demand for instream, wild and scenic, and refuges for the region was about 1.04 million acre-feet, 68% less than 1998 and 26% less than 2000. This accounts for about 8.5 percent of total uses. This includes water that is reserved for instream and wild and scenic river flow, but that can be later used as a supply by downstream users. Refuge supplies, which are supplies applied directly onto wildlife refuges, accounts for 76,300 acre-feet.

Total supplies, including local and imported CVP and SWP surface water, groundwater, and reuse, amounted to 12.3 million acre-feet, 1% less than 1998 and 4% less than 2000.

Sources of Information

- Water Quality Control Plan, Regional Water Quality Control Board
- Watershed Management Initiative Chapter, Regional Water Quality Control Board
- 2002 California 305(b) Report on Water Quality, State Water Resources Control Board
- Bulletin 118 (Draft), California's Groundwater, Update 2003, Department of Water Resources
- Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000
- Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001
- Fresno Metropolitan Water Resources Management Plan Phase III Report Implementation Plan Excerpts, city of Fresno Planning Library Web site, www.fresno.gov/planning_library/default.asp
- Westlands Water District Web site, www.westlandswater.org
- PPIC Statewide Survey: Special Survey of the Central Valley. Public Policy Institute of California. Mark Baldassare. April 2004.
- Grassland Bypass Project Contaminants Investigation - Sacramento Fish and Wildlife Service website: http://sacramento.fws.gov/ec/grassland.htm
- Various articles, Fresno Bee newspaper

Figure 8-1
Tulare Lake Hydrologic Region



Some Statistics

- Area - 17,033 square miles (10.7% of State)
- Average annual precipitation – 15.2 inches
- Year 2000 population - 1,884,675
- 2030 projected population – 3,121,625
- Total reservoir storage capacity - 2,046 TAF
- 2000 irrigated agriculture - 3,219,000 acres

Figure 8-2

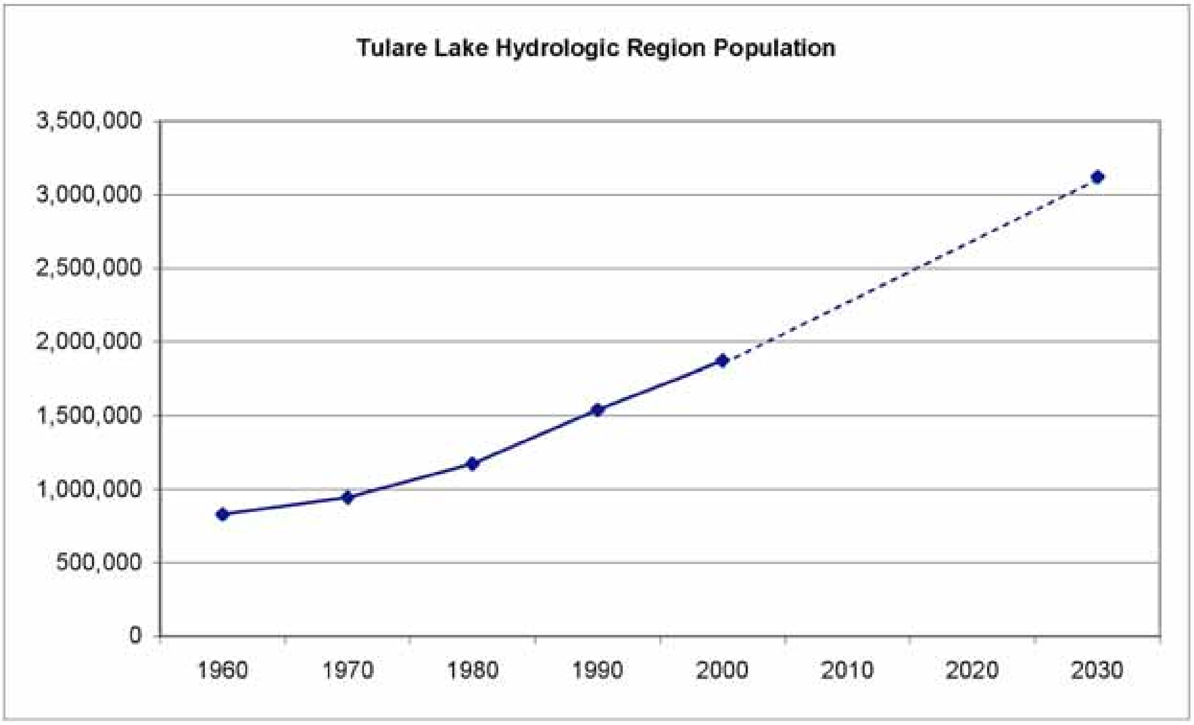

Tulare Lake Hydrologic Region Population
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1960
1970
1980
1990
2000
2010
2020
2030

Figure 8-3
Tulare Lake Region Dedicated Water Supplies For Water Years 1998, 2000, 2001

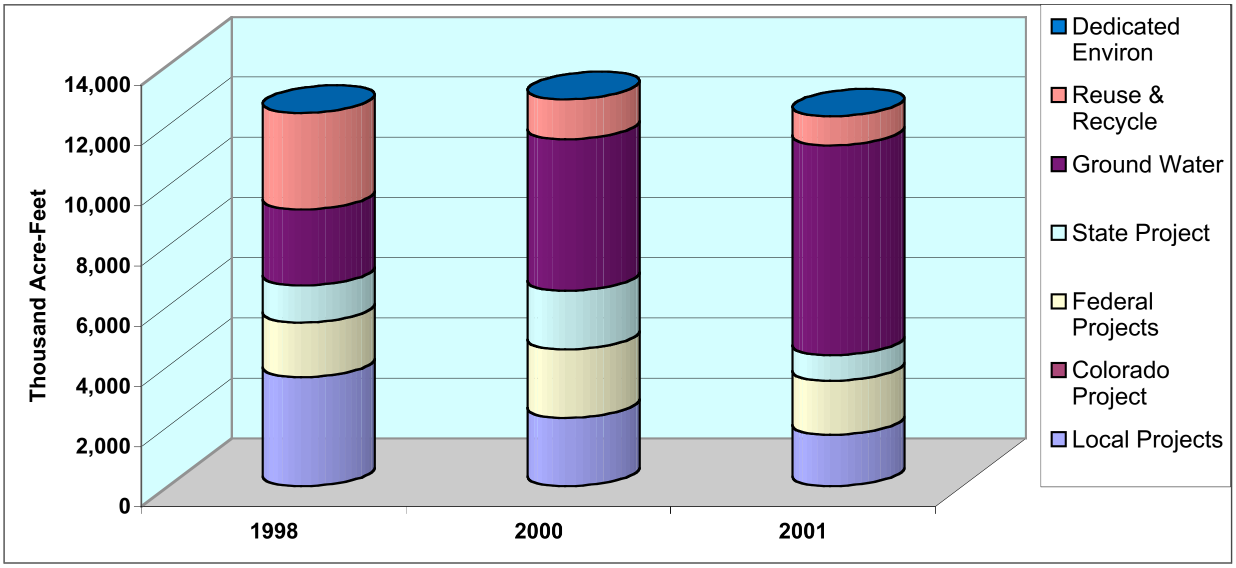


Figure 8-4
Tulare Lake Region Applied Water Uses For Water Years 1998, 2000, 2001

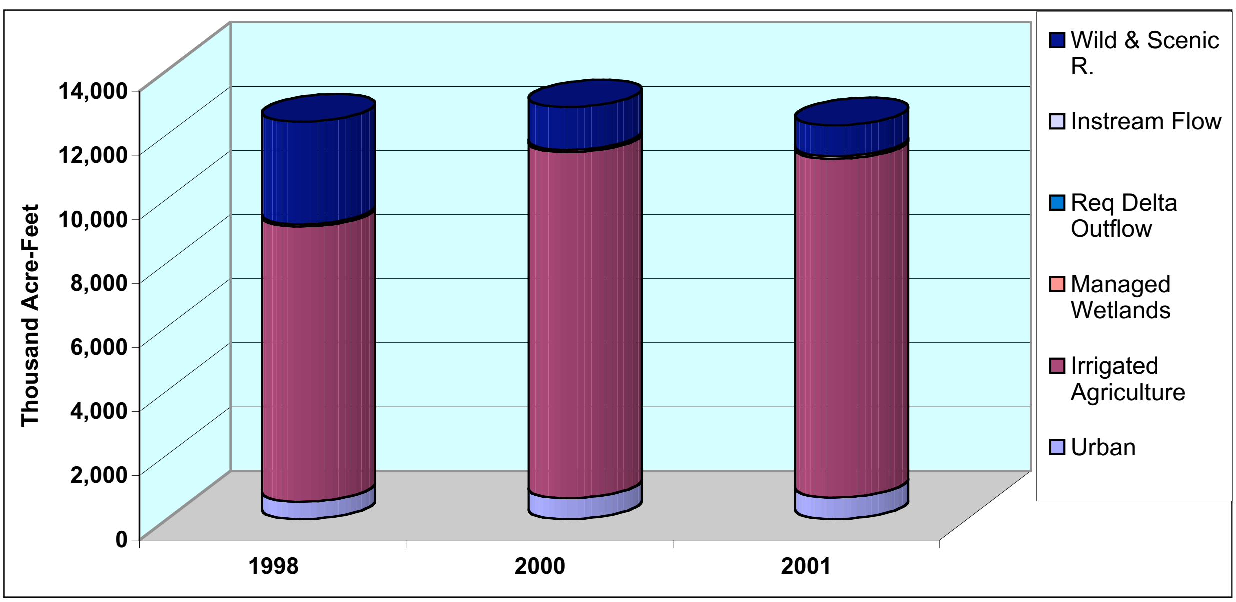


Table 8-1
Tulare Lake Hydrologic Region Water Balance Summary – TAF

Water Entering the Region – Water Leaving the Region = Storage Changes in Region

	Water Year (Percent of Normal Precipitation)		
	1998 (207%)	2000 (93%)	2001 (87%)
Water Entering the Region			
Precipitation	27,306	12,693	11,564
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	3,824	5,579	3,785
Total	**31,130**	**18,272**	**15,349**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	5,401	7,427	7,591
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	2,392	1,614	1,295
Statutory Required Outflow to Salt Sink	0	0	0
Additional Outflow to Salt Sink	477	587	538
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	21,990	10,539	10,243
Total	**30,260**	**20,167**	**19,667**
Storage Changes in the Region [+] Water added to storage [–] Water removed from storage			
Change in Surface Reservoir Storage	438	-57	-141
Change in Groundwater Storage **	432	-1,838	-4,177
Total	**870**	**-1,895**	**-4,318**

Applied Water * (compare with Consumptive Use) * Definition - Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.	8,437	10,725	10,723

**Footnote for change in Groundwater Storage

Change in Groundwater Storage is based upon best available information. Basins in the north part of the State (North Coast, San Francisco, Sacramento River and North Lahontan Regions and parts of Central Coast and San Joaquin River Regions) have been modeled – Spring 1997 to Spring 1998 for the 1998 water year and Spring 1999 to Spring 2000 for the 2000 water year. All other regions and Year 2001 were calculated using the following equation:

GW change in storage =
intentional recharge + deep percolation of applied water + conveyance deep percolation – withdrawals

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow

Table 8-3
Water Portfolios for Water Years 1998, 2000 and 2001

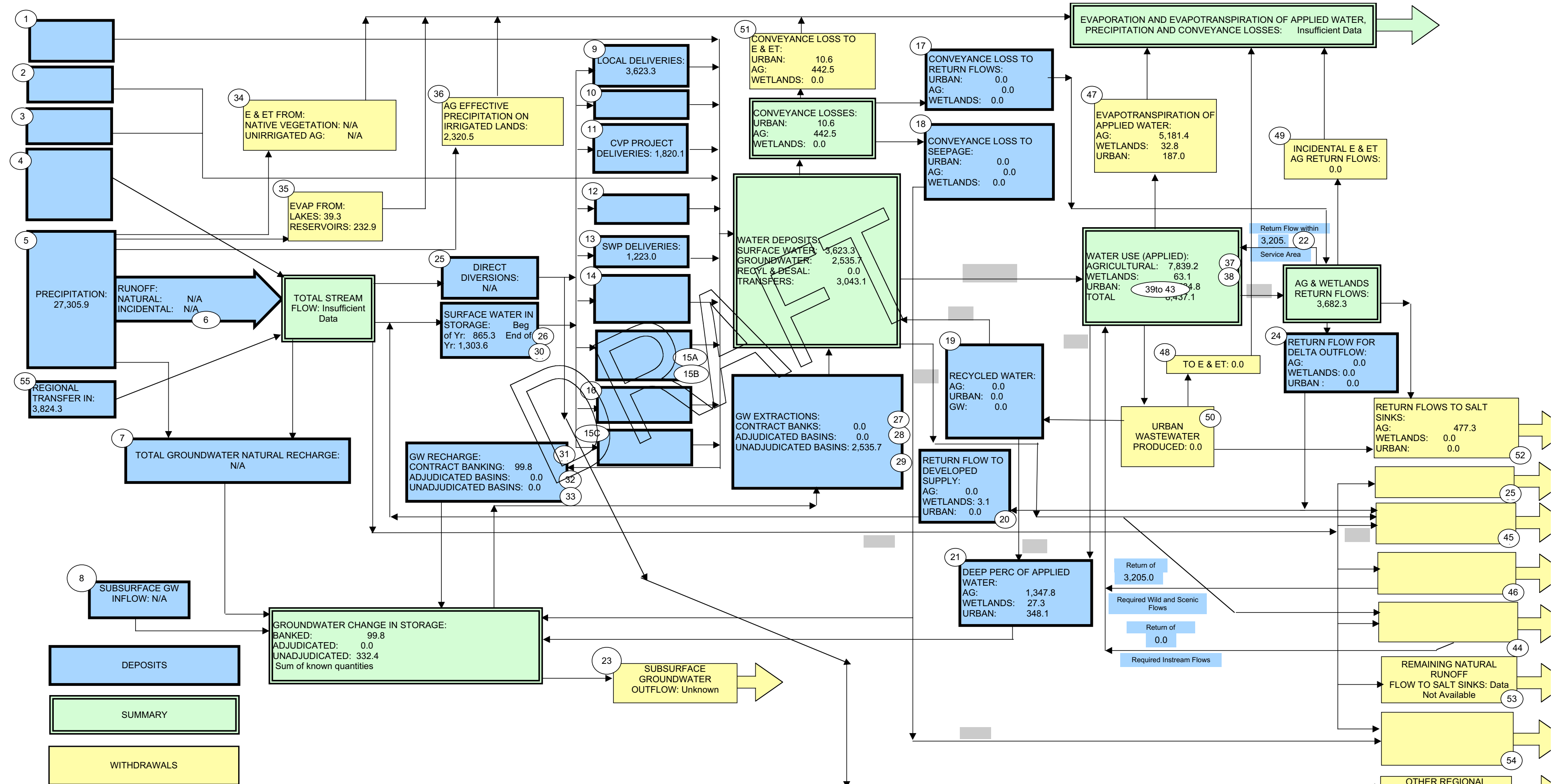
Category	Description	Tulare Lake 1998 (TAF)				Tulare Lake 2000 (TAF)				Tulare Lake 2001 (TAF)				
Inputs:		Water Portfolio	Applied Water	Net Water	Depletion	Water Portfolio	Applied Water	Net Water	Depletion	Water Portfolio	Applied Water	Net Water	Depletion	Data Detail
1	Colorado River Deliveries		-				-				-			PSA/DAU
2	Total Desalination		-				-				-			PSA/DAU
3	Water from Refineries		-				-				-			PSA/DAU
4a	Inflow From Oregon		-				-				-			PSA/DAU
b	Inflow From Mexico		-				-				-			PSA/DAU
5	Precipitation	27,305.9				12,692.9				11,563.6				REGION
6a	Runoff - Natural	N/A				N/A				N/A				REGION
b	Runoff - Incidental	N/A				N/A				N/A				REGION
7	Total Groundwater Natural Recharge	N/A				N/A				N/A				REGION
8	Groundwater Subsurface Inflow	N/A				N/A				N/A				REGION
9	Local Deliveries		3,623.3				2,275.7				1,713.4			PSA/DAU
10	Local Imports		-				-				-			PSA/DAU
11a	Central Valley Project :: Base Deliveries		-				-				-			PSA/DAU
b	Central Valley Project :: Project Deliveries		1,820.1				2,272.3				1,790.5			PSA/DAU
12	Other Federal Deliveries		-				-				-			PSA/DAU
13	State Water Project Deliveries		1,223.0				1,955.5				849.3			PSA/DAU
14a	Water Transfers - Regional		-				-				-			PSA/DAU
b	Water Transfers - Imported		-				-				-			PSA/DAU
15a	Releases for Delta Outflow - CVP		-				-				-			REGION
b	Releases for Delta Outflow - SWP		-				-				-			REGION
c	Instream Flow Applied Water		-				-				-			REGION
16	Environmental Water Account Releases		-				-				-			PSA/DAU
17a	Conveyance Return Flows to Developed Supply - Urban		-				-				-			PSA/DAU
b	Conveyance Return Flows to Developed Supply - Ag		-				-				-			PSA/DAU
c	Conveyance Return Flows to Developed Supply - Managed Wetlands		-				-				-			PSA/DAU
18a	Conveyance Seepage - Urban		-				-				-			PSA/DAU
b	Conveyance Seepage - Ag		-				-				-			PSA/DAU
c	Conveyance Seepage - Managed Wetlands		-				-				-			PSA/DAU
19a	Recycled Water - Agriculture		-				-				-			PSA/DAU
b	Recycled Water - Urban		-				-				-			PSA/DAU
c	Recycled Water - Groundwater		-				-				-			PSA/DAU
20a	Return Flow to Developed Supply - Ag		-				-				-			PSA/DAU
b	Return Flow to Developed Supply - Wetlands		3.1				2.5				2.0			PSA/DAU
c	Return Flow to Developed Supply - Urban		-				-				-			PSA/DAU
21a	Deep Percolation of Applied Water - Ag		1,347.8				1,928.4				2,075.5			PSA/DAU
b	Deep Percolation of Applied Water - Wetlands		27.3				29.7				34.6			PSA/DAU
c	Deep Percolation of Applied Water - Urban		348.1				414.5				431.6			PSA/DAU
22a	Reuse of Return Flows within Region - Ag		-				-				-			PSA/DAU
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S		3,205.0				1,331.1				964.0			PSA/DAU
24a	Return Flow for Delta Outflow - Ag		-				-				-			PSA/DAU
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S		-				-				-			PSA/DAU
c	Return Flow for Delta Outflow - Urban Wastewater		-				-				-			PSA/DAU
25	Direct Diversions	N/A				N/A				N/A				PSA/DAU
26	Surface Water in Storage - Beg of Yr	865.3				708.7				652.2				PSA/DAU
27	Groundwater Extractions - Banked	-				-				-				PSA/DAU
28	Groundwater Extractions - Adjudicated	-				-				-				PSA/DAU
29	Groundwater Extractions - Unadjudicated	2,535.7				5,024.6				6,974.5				REGION
Withdrawals In Thousand Acre-feet														
23	Groundwater Subsurface Outflow	N/A				N/A				N/A				REGION
30	Surface Water Storage - End of Yr	1,303.6				652.2				511.4				PSA/DAU
31	Groundwater Recharge-Contract Banking		99.8				167.4				-3.9			PSA/DAU
32	Groundwater Recharge-Adjudicated Basins		-				-				-			PSA/DAU
33	Groundwater Recharge-Unadjudicated Basins		-				-				-			REGION
34a	Evaporation and Evapotranspiration from Native Vegetation				N/A				N/A				N/A	REGION
b	Evaporation and Evapotranspiration from Unirrigated Ag				N/A				N/A				N/A	REGION
35a	Evaporation from Lakes				39.3				38.5				34.2	REGION
b	Evaporation from Reservoirs				232.9				233.8				190.6	REGION
36	Ag Effective Precipitation on Irrigated Lands		2,320.5				1,121.7				729.6			REGION
37	Agricultural Water Use		7,839.2	6,491.4	5,677.4		10,013.0	8,084.6	7,762.8		9,983.1	7,907.6	7,860.0	PSA/DAU
38	Managed Wetlands Water Use		63.1	35.8	32.8		73.8	44.1	41.5		76.3	41.7	38.9	PSA/DAU
39a	Urban Residential Use - Single Family - Interior		101.6				121.1				126.3			PSA/DAU
b	Urban Residential Use - Single Family - Exterior		155.1				185.1				192.7			PSA/DAU
c	Urban Residential Use - Multi-family - Interior		106.9				127.7				132.8			PSA/DAU
d	Urban Residential Use - Multi-family - Exterior		64.3				76.4				79.7			PSA/DAU
40	Urban Commercial Use		37.5				44.6				46.3			PSA/DAU
41	Urban Industrial Use		53.4				63.8				66.4			PSA/DAU
42	Urban Large Landscape		16.0				19.2				19.8			PSA/DAU
43	Urban Energy Production		-				-				-			PSA/DAU
44	Instream Flow		-	-	-		-	-	-		-	-	-	PSA/DAU
45	Required Delta Outflow		-	-	-		-	-	-		-	-	-	PSA/DAU
46	Wild and Scenic Rivers		3,205.0	-	-		1,331.1	-	-		964.0	-	-	PSA/DAU
47a	Evapotranspiration of Applied Water - Ag				5,181.4				7,162.0				7,320.4	PSA/DAU
b	Evapotranspiration of Applied Water - Managed Wetlands				32.8				41.5				38.4	PSA/DAU
c	Evapotranspiration of Applied Water - Urban				187.0				223.3				232.4	PSA/DAU
48	Evaporation and Evapotranspiration from Urban Wastewater				-				-				-	REGION
49	Return Flows Evaporation and Evapotranspiration - Ag				-				-				-	PSA/DAU
50	Urban Waste Water Produced	-				-				-				REGION
51a	Conveyance Evaporation and Evapotranspiration - Urban				10.6				12.8				13.3	PSA/DAU
b	Conveyance Evaporation and Evapotranspiration - Ag				442.5				482.0				382.1	PSA/DAU
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands				-				-				-	PSA/DAU
d	Conveyance Loss to Mexico				-				-				-	PSA/DAU
52a	Return Flows to Salt Sink - Ag				477.3				587.1				537.5	PSA/DAU
b	Return Flows to Salt Sink - Urban				-				-				-	PSA/DAU
c	Return Flows to Salt Sink - Wetlands				-				-				0.5	PSA/DAU
53	Remaining Natural Runoff - Flows to Salt Sink				-				-				-	REGION
54a	Outflow to Nevada				-				-				-	REGION
b	Outflow to Oregon				-				-				-	REGION
c	Outflow to Mexico				-				-				-	REGION
55	Regional Imports	3,824.3				5,579.4				3,784.6				REGION
56	Regional Exports	2,391.7				1,614.4				1,295.0				REGION
59	Groundwater Net Change in Storage	432.2				-1,837.4				-4,176.8				REGION
60	Surface Water Net Change in Storage	438.3				-56.5				-140.8				REGION
61	Surface Water Total Available Storage	2,046.1				2,046.1				2,046.1				REGION

Colored spaces are where data belongs. N/A Data Not Available "-" Data Not Applicable "0" Null value

Table 8-4
Tulare Lake Hydrologic Region Water Use and Distribution of Dedicated Supplied

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	16.0			19.2			19.8		
Commercial	37.5			44.6			46.3		
Industrial	53.4			63.8			66.4		
Energy Production	0.0			0.0			0.0		
Residential - Interior	208.5			248.7			259.1		
Residential - Exterior	219.4			261.4			272.4		
Evapotranspiration of Applied Water		187.0	187.0		223.3	223.3		232.4	232.4
Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Applied Water	10.6			12.8			13.3		
Conveyance Losses - Evaporation		10.6	10.6		12.8	12.8		13.3	13.3
Conveyance Losses - Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.7			2.9			0.5		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**546.1**	**197.6**	**197.6**	**653.4**	**236.1**	**236.1**	**677.8**	**245.7**	**245.7**
Agriculture									
On-Farm Applied Water	7,006.9			9,677.6			9,933.8		
Evapotranspiration of Applied Water		5,181.4	5,181.4		7,162.0	7,162.0		7,320.4	7,320.4
Irrecoverable Losses		477.3	477.3		587.1	587.1		537.5	537.5
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Applied Water	753.7			787.9			590.5		
Conveyance Losses - Evaporation		423.8	423.8		468.3	468.3		380.0	380.0
Conveyance Losses - Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	832.3			335.4			49.3		
GW Recharge Evap + Evapotranspiration		18.7	18.7		13.7	13.7		2.1	2.1
Total Agricultural Use	**8,592.9**	**6,101.2**	**6,101.2**	**10,800.9**	**8,231.1**	**8,231.1**	**10,573.6**	**8,240.0**	**8,240.0**
Environmental									
Instream									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	3,205.0			1,331.1			964.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	63.1			73.8			76.3		
Evapotranspiration of Applied Water		32.8	32.8		41.5	41.5		38.4	38.4
Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		3.1	0.0		2.5	0.0		2.5	0.5
Conveyance Losses - Applied Water	0.0			0.0			0.0		
Conveyance Losses - Evaporation		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	63.1	35.9	32.8	73.8	44.0	41.5	76.3	40.9	38.9
Total Environmental Use	**3,268.1**	**35.9**	**32.8**	**1,404.9**	**44.0**	**41.5**	**1,040.3**	**40.9**	**38.9**
TOTAL USE AND LOSSES	**12,407.1**	**6,334.7**	**6,331.6**	**12,859.2**	**8,511.2**	**8,508.7**	**12,291.7**	**8,526.6**	**8,524.6**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	3,623.3	3,623.3	3,621.6	2,275.6	2,275.6	2,274.7	1,713.4	1,713.4	1,712.6
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	1,820.1	1,820.1	1,819.3	2,272.3	2,272.3	2,271.4	1,790.5	1,790.5	1,789.7
Other Federal Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWP Deliveries	1,223.0	1,223.0	1,222.4	1,955.5	1,955.5	1,954.7	849.3	849.3	848.9
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	-331.7	-331.7	-331.7	2,007.8	2,007.8	2,007.8	4,173.4	4,173.4	4,173.4
Artificial Recharge	814.3			324.7			48.9		
Deep Percolation	2,053.1			2,692.2			2,752.2		
Reuse/Recycle									
Reuse Surface Water	3,205.0			1,331.1			964.0		
Recycled Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLIES	**12,407.1**	**6,334.7**	**6,331.6**	**12,859.2**	**8,511.2**	**8,508.7**	**12,291.7**	**8,526.6**	**8,524.6**
Balance = Use - Supplies	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Figure 8-5
Tulare Lake Hydrologic Region 1998 Flow Diagram
In Thousand Acre-Feet (TAF)



March 29, 2005

Figure 8-6
Tulare Lake Hydrologic Region 2000 Flow Diagram
In Thousand Acre-Feet (TAF)

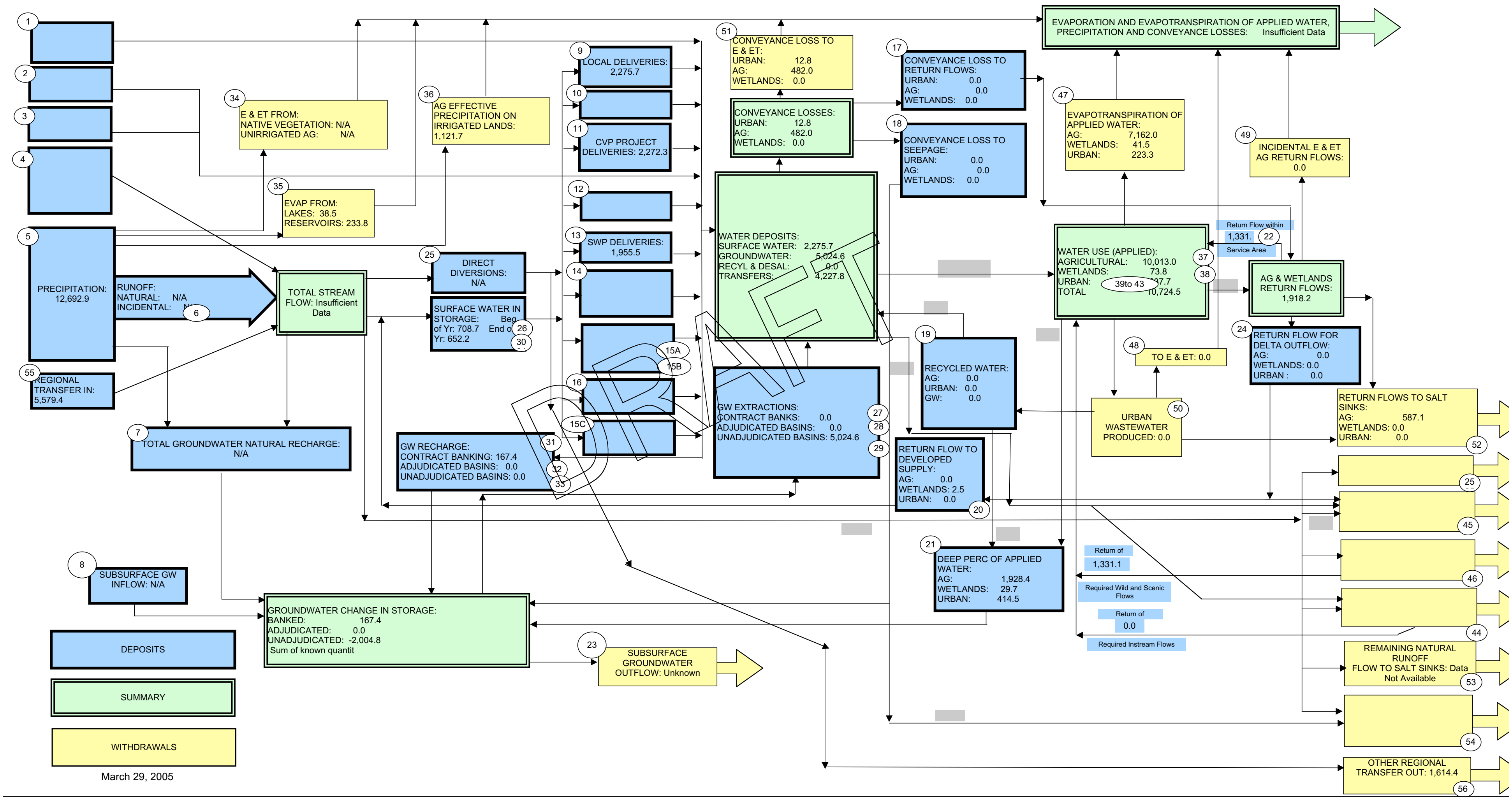


Figure 8-7
Tulare Lake Hydrologic Region 2001 Flow Diagram
In Thousand Acre-Feet (TAF)